CloudSat:

Science, Mission, and Educational Outreach

Matt Rogers[1] and Peter Falcon[2]

11th Annual GLOBE Conference
San Antonio, Texas

[1.] Colorado State University, Fort Collins, CO
[2.] Jet Propulsion Laboratory, Pasadena, CA

Overview

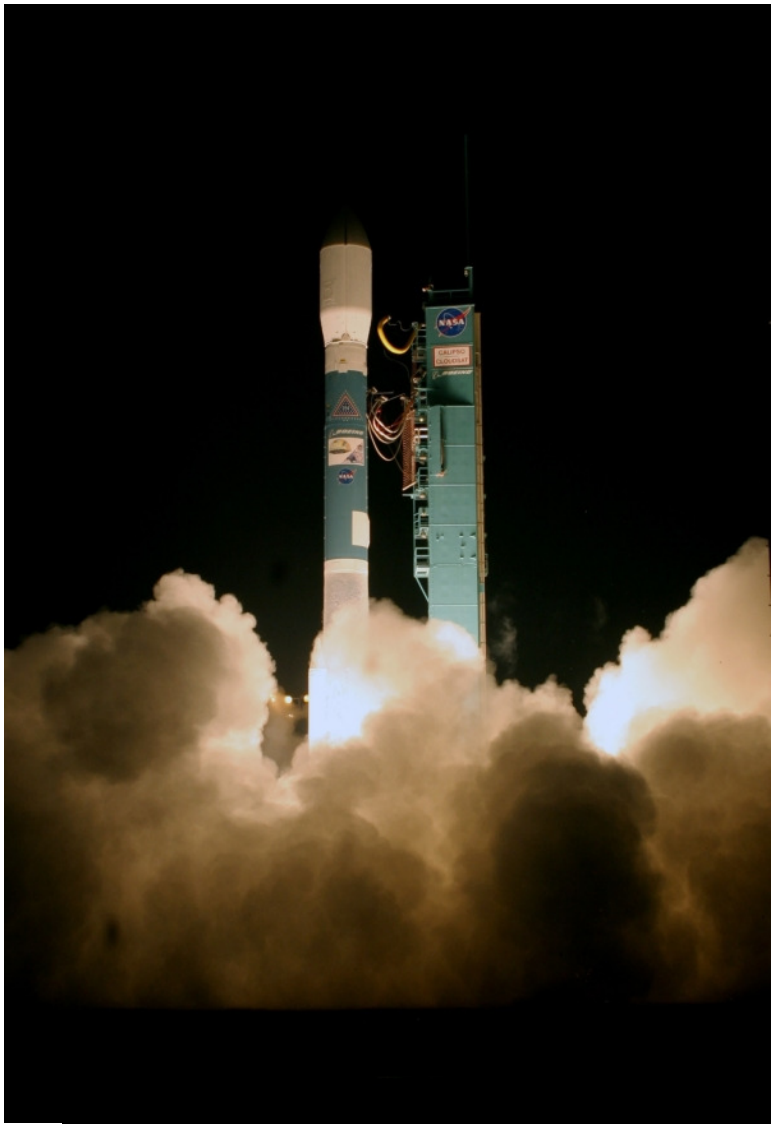
CloudSat - what it is, what it does, why it matters

The CloudSat Education Network (CEN) - Student-based observation network as part of outreach

Development of State/National-Standard based projects using CloudSat, GLOBE, and CEN observations for science exploration

JPL Colorado State University

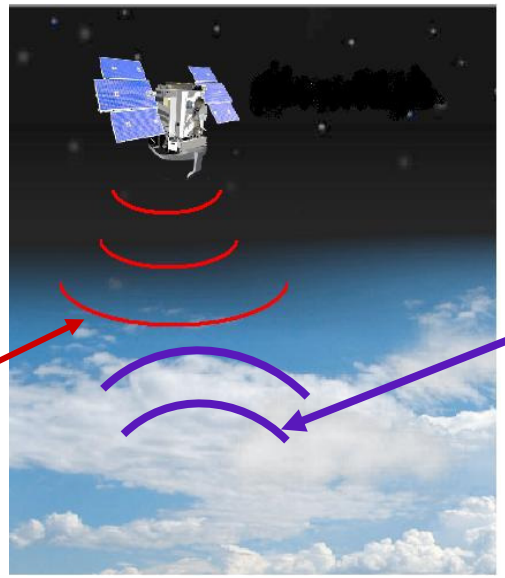
What is CloudSat?



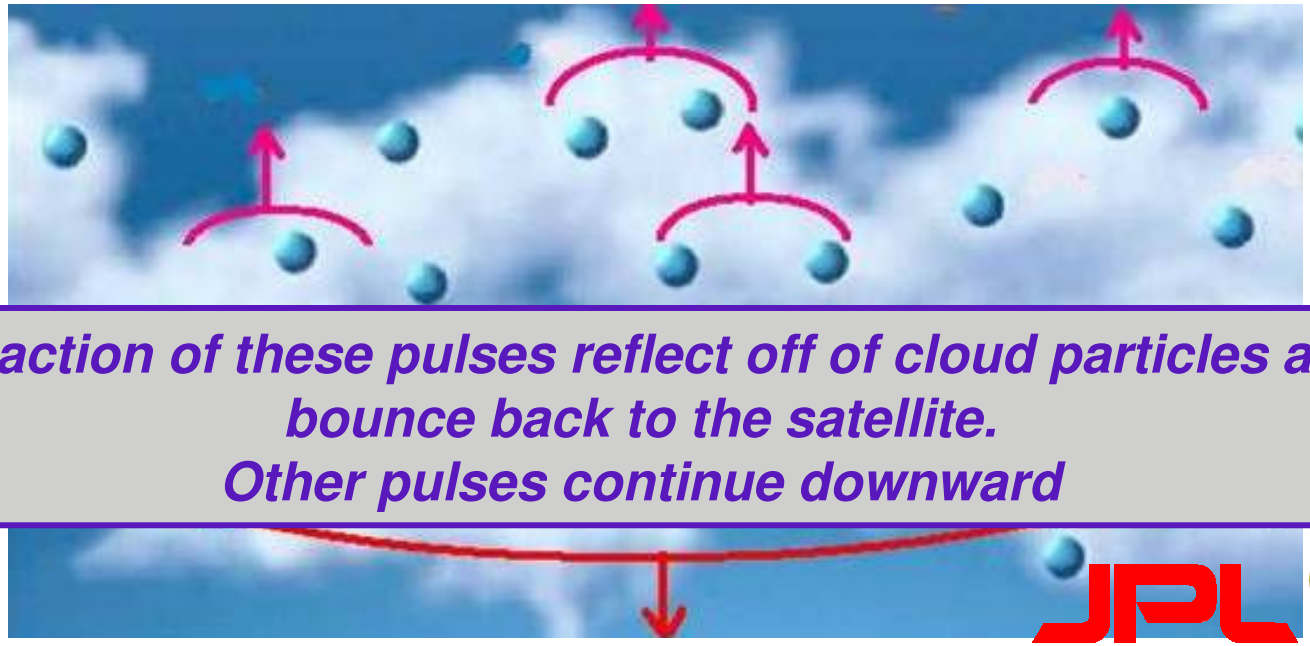
- Space-based cloud radar
- Designed to see cloud droplets (as opposed to rain)
- Orbiting in formation with several other different satellites (the ‘A-Train’)
- 98-minute orbital period, repeats every 10-16 days
- Crosses the equator around 1:00pm local solar time each day
- Launched 28 April 2006 from Vandenburg AFB, California

How the CloudSat Radar Works

As CloudSat orbits Earth, it transmits short pulses of microwave energy down into the Earth's atmosphere.



The CloudSat radar measures the time delay and magnitude of the reflected signal



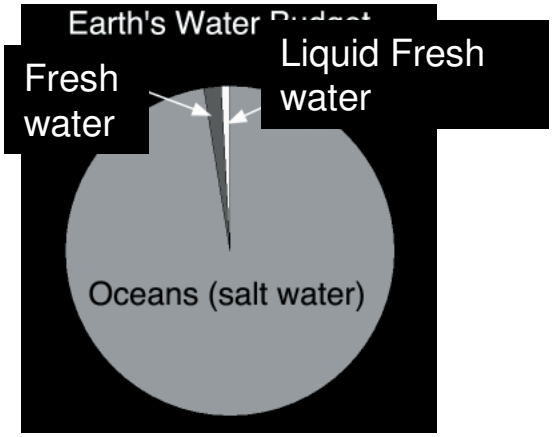
A fraction of these pulses reflect off of cloud particles and bounce back to the satellite.
Other pulses continue downward

JPL

Colorado State University

Why CloudSat?

Clouds are the ultimate source of the planet's fresh water supply



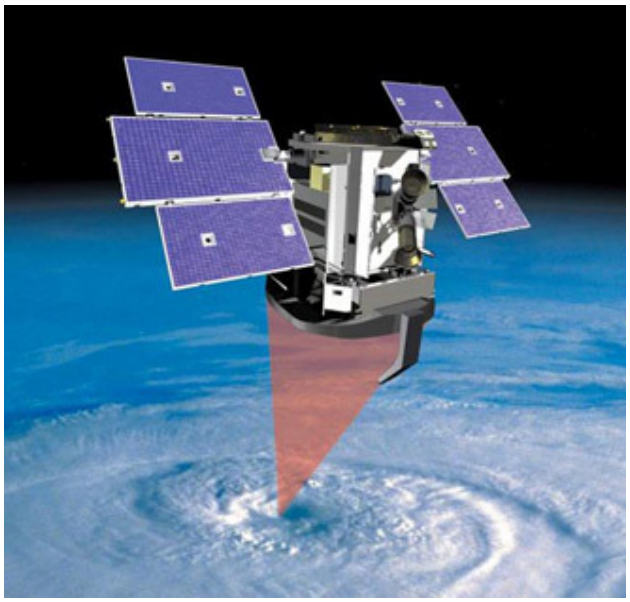
Clouds produce energy that fuel weather and storms

Clouds affect the energy that flows in and out of Earth, shaping our climate

Outreach component: the CloudSat Education Network

The CloudSat Education Network (CEN) is an international network of schools making surface observations (based on the GLOBE Atmosphere protocol) to compare with CloudSat radar data.

Students are GLOBE-trained and take both GLOBE and CEN observations, which are then reported via the CEN website (and forwarded to GLOBE)



Observations are timed to coincide with overpasses of CloudSat - happens every 10-16 days for any single school

Observations include measurement of temperature, cloud type and cover, contrail information, and precipitation, along with cloud photos!

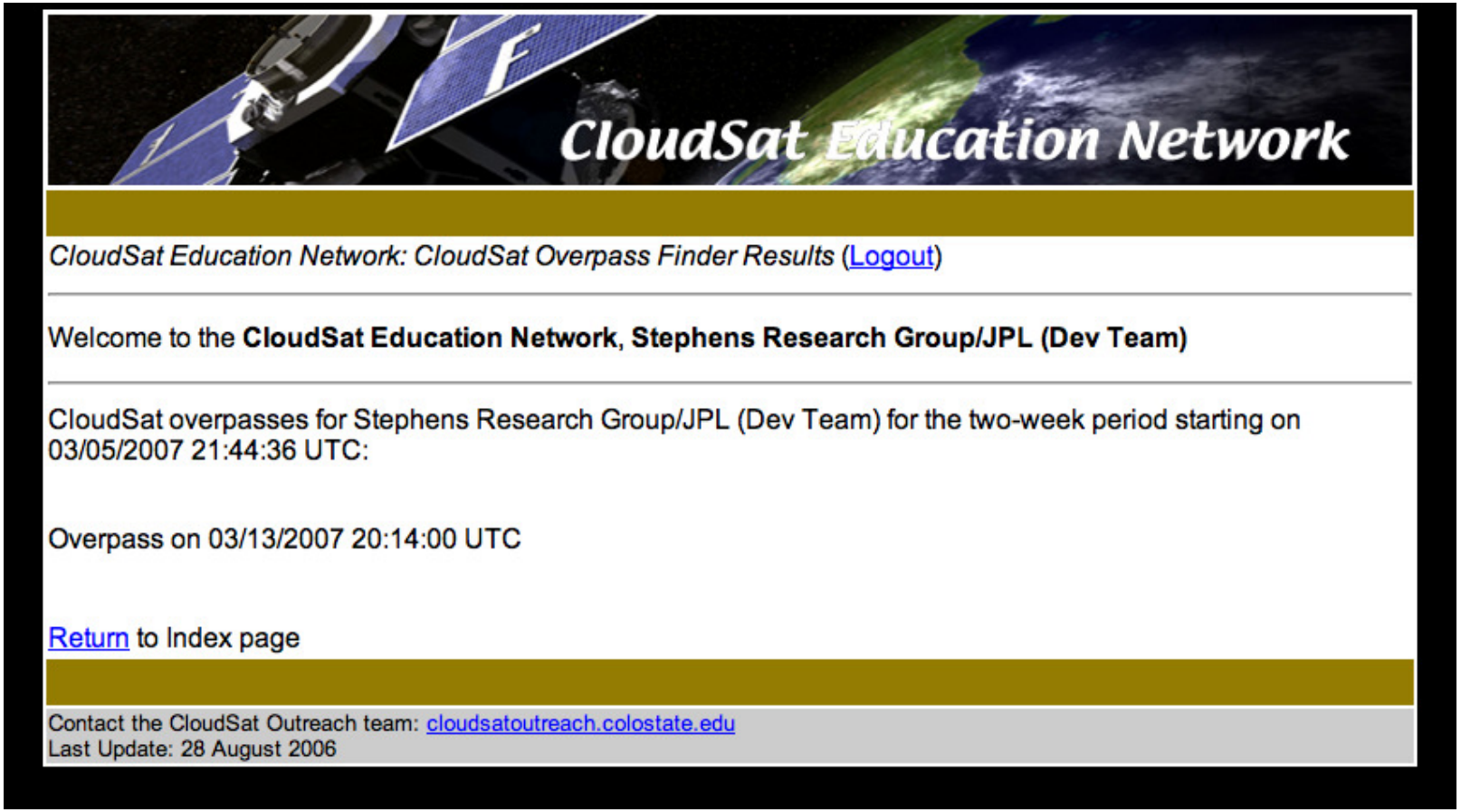
JPL Colorado State University

A day in the life of a CEN School

Schools log in from the CloudSat webpage using their GLOBE ID and the CEN password assigned to them

The first page they see is the index page, which contains links to: the data entry page, the CloudSat overpass predictor tool, and data and photo retrieval pages

First, we want to find when CloudSat will be overhead…



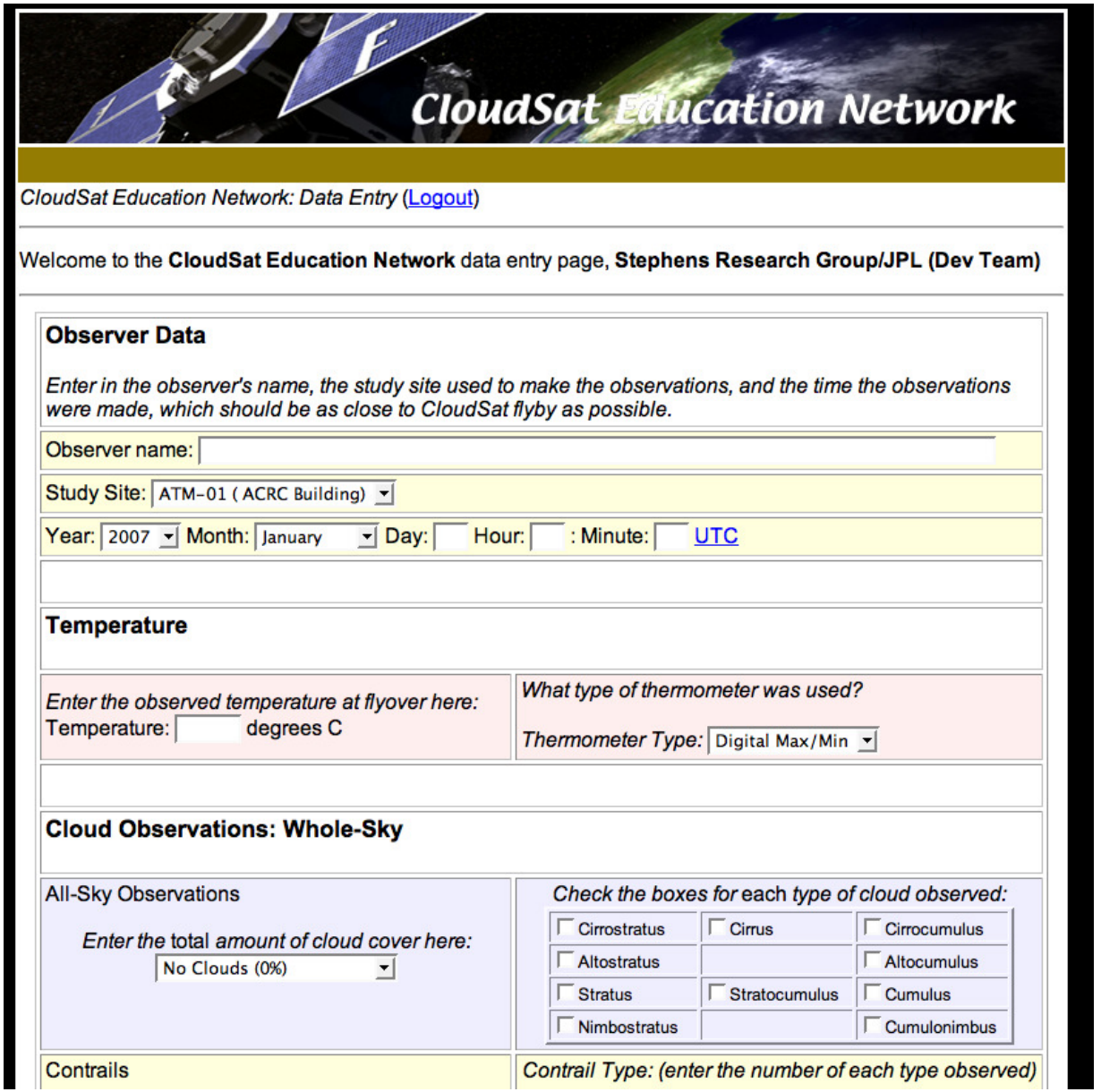
…using the overpass predictor, we find out when CloudSat will be over our school.

On that date and time, we go out and take our measurements!

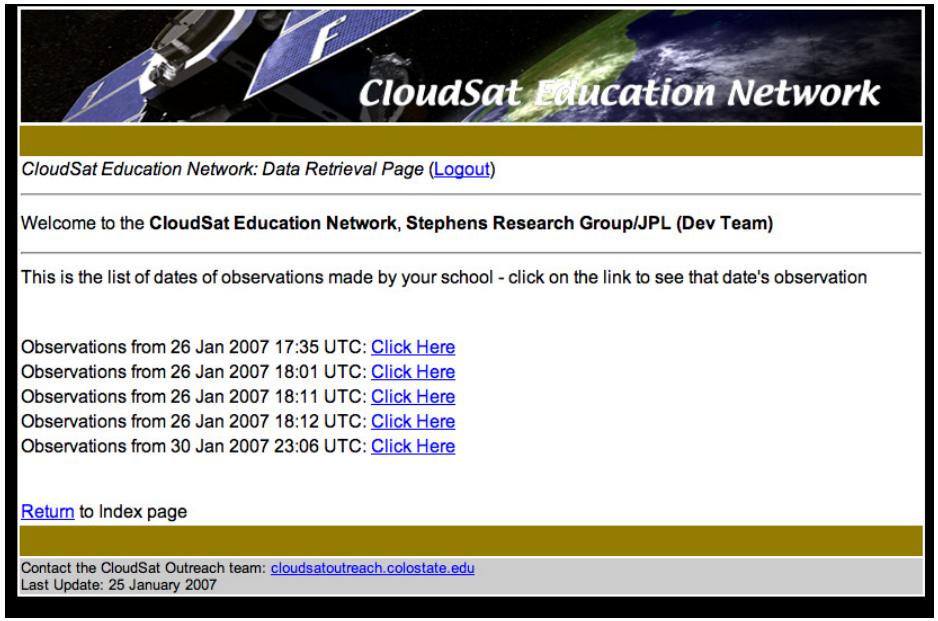
Once our data is collected, we go back to the webpage, and use the data entry page to submit our observations and photos.

Data is sent to CEN and to GLOBE as well - no need to enter your GLOBE Atmosphere observations twice!

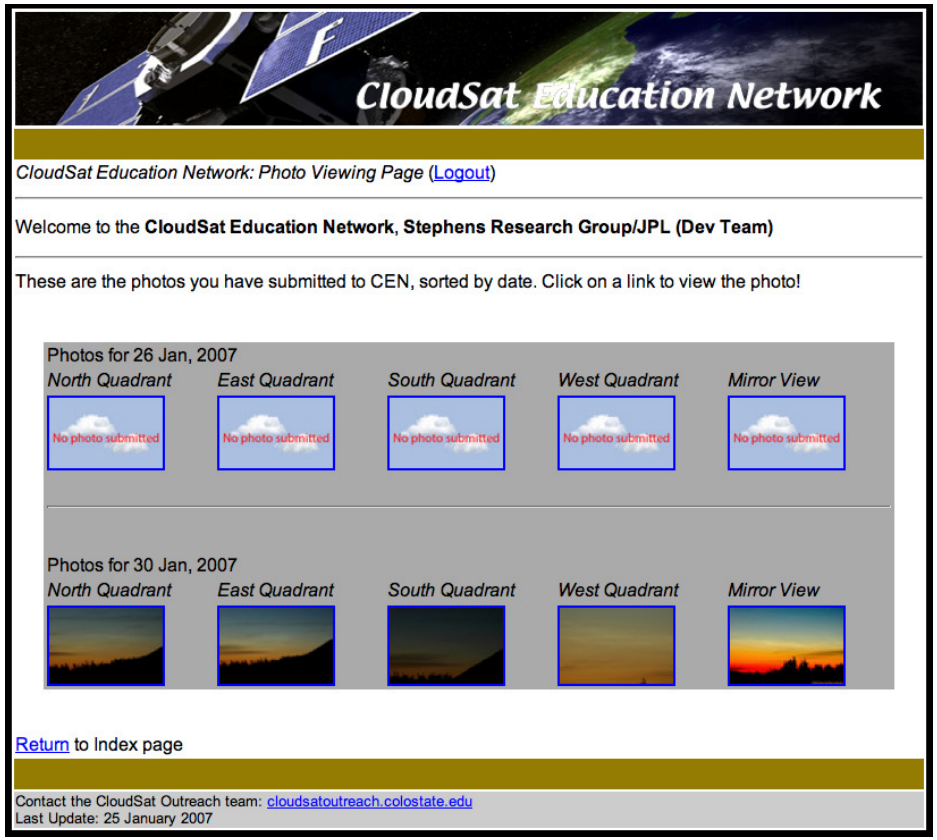
Data is stored locally, as well as on the GLOBE homepage.



CEN Data Retrieval

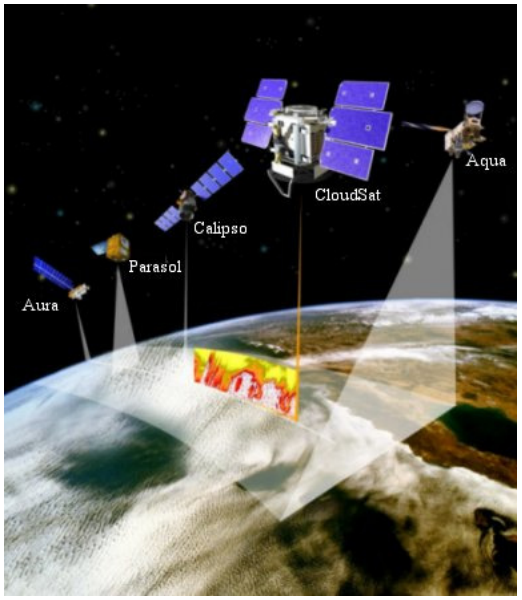


Students can look at their text observations…



…or look at the photos they submitted!

Using the data in state standards-based research projects



Student observations useful on several levels - goal is to use observations in meaning research

Teachers constrained to set curriculum based on science standards - little ‘wiggle room’ in what can be taught and when

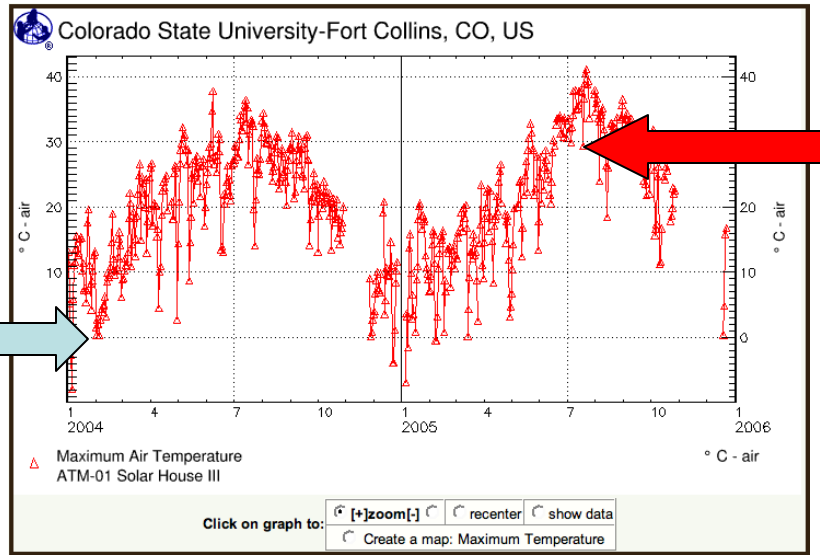
Solution: Use CloudSat, GLOBE, and CEN observations to answer the scientific questions that *are* posed in state standards

Develop ready-to-go projects, based off of science standards for different grade levels, where students help answer some of the same scientific questions that CloudSat researchers are looking at

Make scientists and staff available for development of new projects

JPL Colorado State University

Elementary School - Identify clouds, identify seasons



Based on NSES K-4 Earth and Space Science Content Standard

Students record GLOBE Atmosphere observations along with CEN cloud type observations over the year - observe how clouds change as the seasons change

Inquiry - why is this so? Are there links between GLOBE observations (temperature, humidity, etc.) and the types of clouds you see?

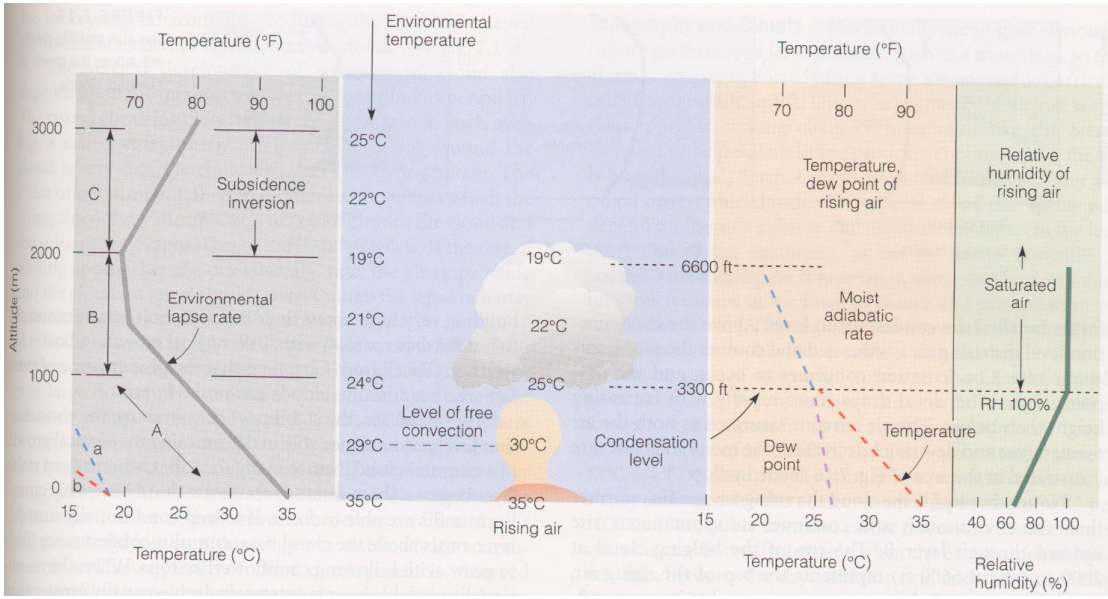
Emphasis: developing observation and description skills

High School - Explore the thermodynamic properties of clouds

Basis: Physical, Space and Earth Science Content Standards in NSES (standards B and D, respectively)

Topics touched on: conservation of energy, latent heat of condensation, buoyancy of fluids

Emphasis on investigating the state of the natural world based on observations

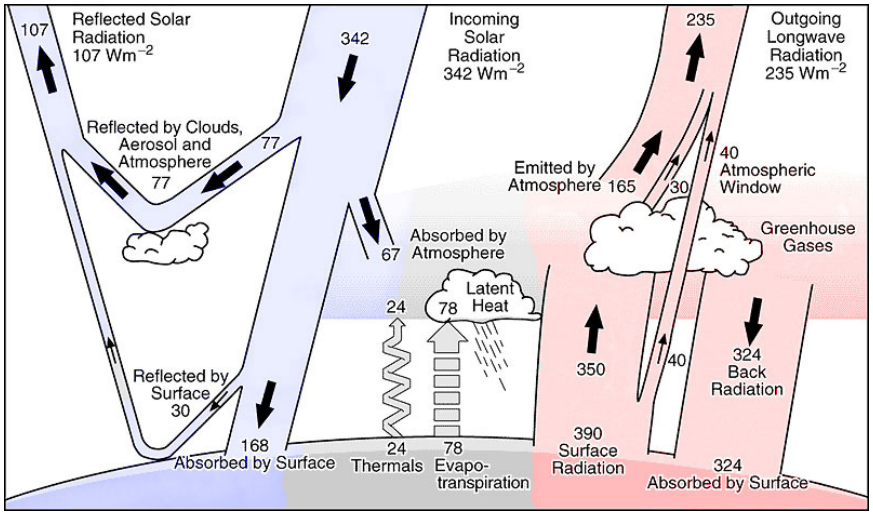


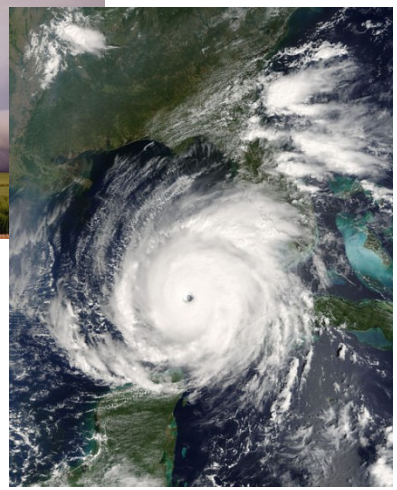
Project integrated into earth science curricula dealing with standards - additional unit on cloud formation based on standards available

Students take cloud observations and use knowledge of cloud formation mechanisms to assess environmental conditions (instability, lifting of airmasses, etc.)

Learn to identify environmental conditions that favor certain cloud types

High School - Explore the thermodynamic properties of clouds





Scientific Inquiries:

Climate change: understanding environmental influences on cloud formation, combined with knowledge of how clouds in turn influence the environment

Severe Weather: what are the conditions that favor flooding, damaging hail and winds, or tornadoes? What are the optimal environmental conditions for hurricanes?

Develop links between science content taught in the standards and these (and other) inquiries

JPL Colorado State University

Development Outline

1.) Identify key standards to be addressed

2.) Pose scientific question (that can be investigated using GLOBE and CEN observations - that's where we come in)

3.) Have students develop hypothesis relating to scientific questions, identify observations needed to test hypothesis

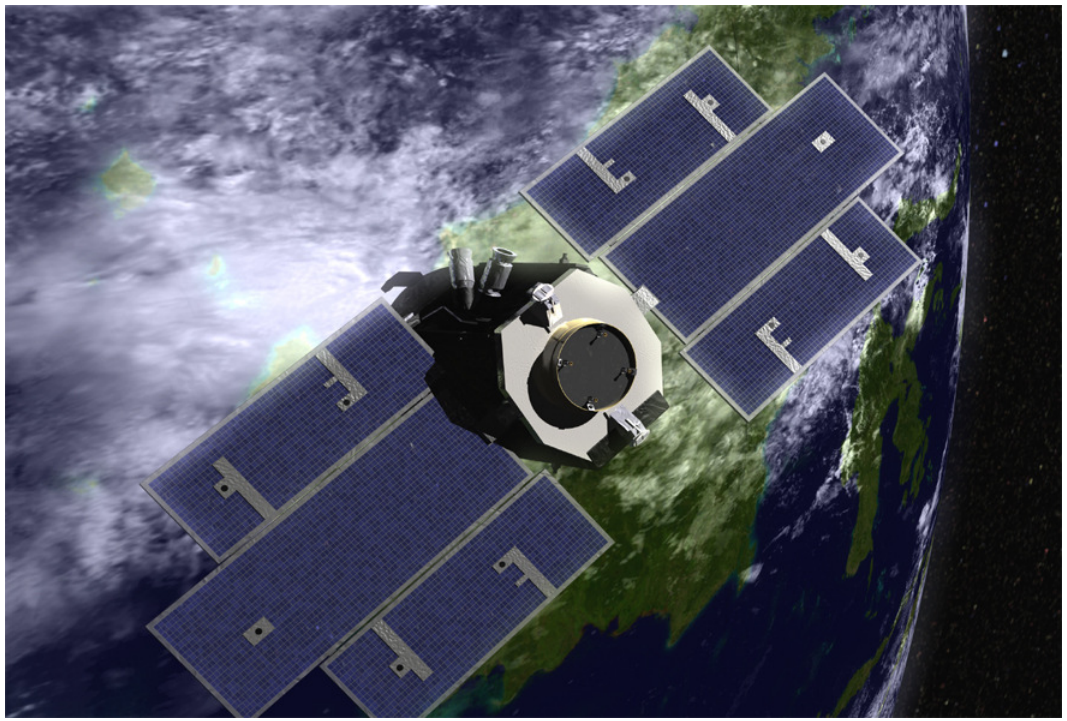
4.) Identify materials needed, timeline of project

5.) Make observations as necessary, analyze results

6.) Scientific results and feedback with scientists involved - potential for discoveries are found here!

JPL Colorado State University

Where we are, where we're going



Intro projects developed for K-5 and high school level, currently developing middle school project

Road-test of projects with interested CEN teachers - initial projects to be tested and refined during 2007-2008 school year

Feedback from teachers, scientists, and GLOBE on results will dictate future projects and the direction they take

By end of mission, we'll have developed several observation-based projects for exploration of the governing principals of the environment, using CloudSat and GLOBE observations

We'd like to hear from you!

JPL Colorado State University